



**B O A R D O F S T U D I E S**  
NEW SOUTH WALES

**2001**

**HIGHER SCHOOL CERTIFICATE  
EXAMINATION**

# Software Design and Development

## **General Instructions**

- Reading time – 5 minutes
- Working time – 3 hours
- Write using black or blue pen
- Draw diagrams using pencil

**Total marks – 100**

**Section I** Pages 2–9

**20 marks**

- Attempt Questions 1–20
- Allow about 35 minutes for this section

**Section II** Pages 11–17

**60 marks**

- Attempt Questions 21–23
- Allow about 1 hour and 50 minutes for this section

**Section III** Pages 18–23

**20 marks**

- Attempt either Question 24 or Question 25
- Allow about 35 minutes for this section

## Section I

20 marks

Attempt Questions 1–20

Allow about 35 minutes for this section

Use the multiple-choice answer sheet.

Select the alternative A, B, C or D that best answers the question. Fill in the response oval completely.

**Sample:**  $2 + 4 =$  (A) 2 (B) 6 (C) 8 (D) 9  
A  B  C  D

If you think you have made a mistake, put a cross through the incorrect answer and fill in the new answer.

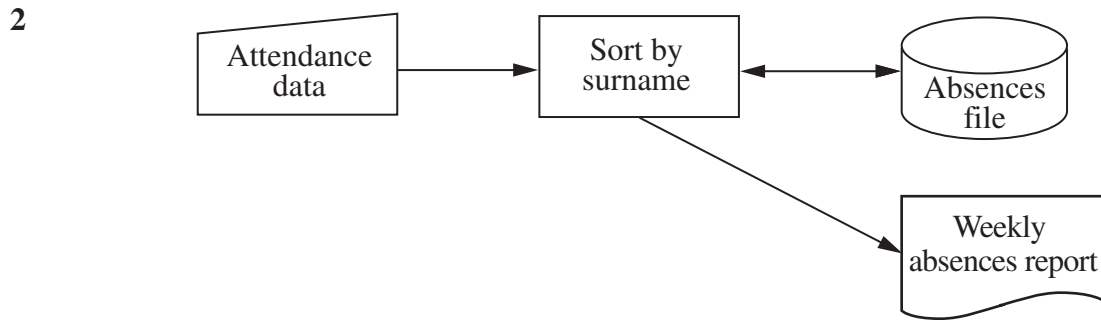
A  B  C  D

If you change your mind and have crossed out what you consider to be the correct answer, then indicate the correct answer by writing the word **correct** and drawing an arrow as follows.

A  B  C  D   
*correct* ↙

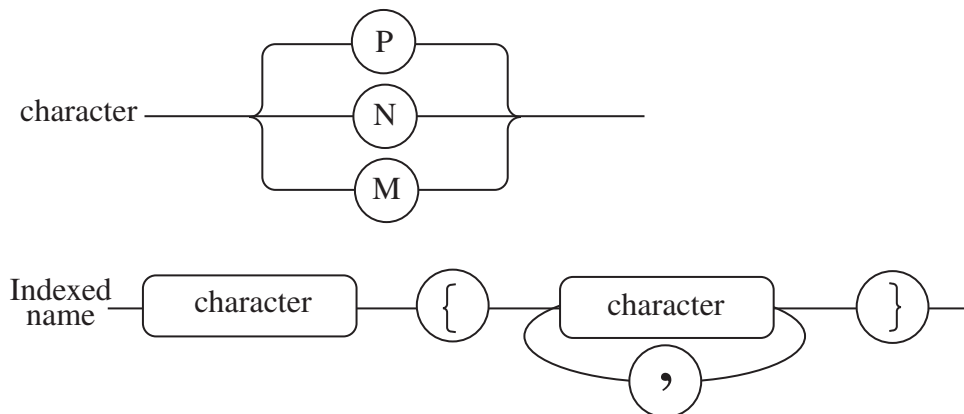
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- 1 In executing a program, two numbers are to be added. Where would the result of this addition be initially stored?
- (A) An address register
  - (B) An accumulator
  - (C) Random access memory
  - (D) Read only memory



What is this diagram an example of?

- (A) A data dictionary
  - (B) A data flow diagram
  - (C) A structure diagram
  - (D) A system flowchart
- 3 The syntax definition for a programming language is given by:



Which of the following is a syntactically correct indexed name?

- (A) MN{P}
- (B) M{N,P}
- (C) M{N,P}
- (D) M{NP,}

- 4 During which stage of the software development cycle would user documentation of the software solution be produced?
- (A) Defining and understanding the problem
  - (B) Planning and design of software solutions
  - (C) Implementation of software solutions
  - (D) Testing and evaluation of software solutions
- 5 A real estate agent has been keeping information on rental properties in a spreadsheet. The real estate agency would now like to convert all of the data to a database system as quickly as possible.
- What would be the most appropriate system conversion method?
- (A) Direct conversion
  - (B) Parallel conversion
  - (C) Pilot conversion
  - (D) Phased conversion
- 6 Under what circumstances is it necessary to create a prototype?
- (A) When only some of the system's requirements are known
  - (B) When only one copy of the program is created
  - (C) When the program is not going to be updated
  - (D) When the project team does not know where to start
- 7 Why would a systems analyst most likely use CASE tools?
- (A) To reduce the number of decisions
  - (B) To allow the user to develop software
  - (C) To speed up the production of the variable lists
  - (D) To speed up the development of large systems

- 8 What would a programmer be likely to use in order to understand the links between the various modules of a system?
- (A) A structure diagram
  - (B) A decision tree
  - (C) A system flowchart
  - (D) A decision table

- 9 A program that appears to be operating correctly fails to produce an expected result, and runs indefinitely.

What is the most likely type of error?

- (A) Syntax error
  - (B) Run-time error
  - (C) Logical error
  - (D) I/O error
- 10 The elements of a one-dimensional array *stadium\_seat* are shown. The smallest index is 17.

6	3	9	7	11	8
---	---	---	---	----	---

What is the value of  $stadium\_seat[20] - stadium\_seat[18]$ ?

- (A) 1
- (B) 2
- (C) 3
- (D) 4

- 11 The table gives a classification of postal articles by weight.

<i>Article weight (g)</i>	<i>Type of article</i>
Up to 749	letter
750–999	small parcel
1000 and above	large parcel

The following algorithm is designed to determine whether an article is a letter, small parcel or large parcel. Within the algorithm, there is a logical error.

```
BEGIN article_sort
  READ article_weight
  IF (article_weight <750) THEN
    display 'The article is a letter'
  ELSE
    IF (article_weight >=750) OR (article_weight <1000)
      display 'The article is a small parcel'
    ELSE
      display 'The article is a large parcel'
    ENDIF
  ENDIF
END
```

Which test data item will identify this logical error?

- (A) 50
  - (B) 500
  - (C) 750
  - (D) 1000
- 12 Which modelling tool best represents the relationships between a system and the external entities?
- (A) A decision table
  - (B) A data flow diagram
  - (C) An IPO diagram
  - (D) A storyboard

Refer to the algorithm of a procedure to answer Questions 13 and 14.

```
BEGIN FindDogOwner (req_microchipno, req_owname)
  found = false
  open (Owner) indexed by microchipno
  read (Owner) microchipno, owname
  WHILE not found OR not end of file
    IF microchipno = req_microchipno THEN
      req_owname = owname
      found = true
    ENDIF
    read (Owner) microchipno, owname
  ENDWHILE
  IF not found THEN
    print 'no owner recorded'
  ELSE
    print 'owner is '; owname
  ENDIF
END
```

**13** What type of variable is 'found'?

- (A) A constant
- (B) A flag
- (C) A string
- (D) A trigger

**14** What type of data are 'req\_microchipno' and 'req\_owname'?

- (A) Parameters passed from a calling procedure
- (B) Variables returned to a called procedure
- (C) Transitional parameters
- (D) Transitional variables

**15** To ensure that the software solution is implemented in an appropriate time frame, what project management technique could be utilised?

- (A) Data flow diagram
- (B) Gantt chart
- (C) IPO diagram
- (D) Pseudocode

**16** A programmer has written a program in a high-level language that can be interpreted or compiled. During the development, the program has been tested using an interpreter.

Which statement about the finalisation of the program is true?

- (A) It should be compiled in an attempt to make it execute faster.
- (B) It should be either compiled or interpreted, as they are equivalent.
- (C) It should be interpreted, as it will run faster.
- (D) It should be interpreted, as this is the only way it will run.

**17** In order to access information on the Internet, a visually impaired person may use screen-reading software that converts text to sound.

What should developers do to make a website inclusive of the visually impaired?

- (A) Choose web-safe colours
- (B) Supplement graphics with text
- (C) Have only text on each page
- (D) Avoid the use of JavaScript

**18** A systems analyst has consulted the users during the planning stage of the project to develop new payroll management software. The analyst does not communicate with the users again until the training program for the new software begins.

Which statement best describes the appropriateness of this approach?

- (A) It is appropriate because users do not understand the design process.
- (B) It is appropriate because users need to understand how to use the software before it becomes active.
- (C) It is not appropriate because the users should have the final say about what the software should look like.
- (D) It is not appropriate because the users' perspective has not been acknowledged during the design stage.



- 19** A software designer has decided to include a button on each of the screens of a program to allow the user to navigate back to the main menu screen. It was decided that this button should always be located at the bottom left corner and be the same colour and shape.

How are these design decisions best described?

- (A) Bad, because the programmers cannot demonstrate their skill
  - (B) Bad, because the user will become bored with the screens
  - (C) Good, because they demonstrate consistency of approach by the programmer
  - (D) Good, because they reduce the need for choices by the user
- 20** An installation guide is produced during the development of a piece of software. Who is the person most likely to be responsible for producing this document?
- (A) Data entry operator
  - (B) Divisional manager
  - (C) Maintenance person
  - (D) Software engineer

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## **Section II**

**60 marks**

**Attempt Questions 21–23**

**Allow about 1 hour and 50 minutes for this section**

Answer each question in a SEPARATE writing booklet. Extra writing booklets are available.

If you include diagrams in your answer, ensure that they are clearly labelled.

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**Question 21** (20 marks)

**Please turn over**

**Question 21** (20 marks) Use a SEPARATE writing booklet.

- (a) The following algorithm segment is *DisplayTrain*, part of a major software development project designed to manage and operate an electric railway system. *DisplayTrain* is intended to record the location of any train within the rail network, and display a train indicator on a large display screen.

*DisplayTrain* is intended to operate by broadcasting a message that requests the location of the train. A signal is returned indicating the location in terms of X and Y coordinates that describe its grid reference. The TrainID is then displayed on a map at the location of the X and Y coordinates. The system is in a continuous loop that monitors trains at all times. TrainID is a unique value allocated by the process ReadTrainID.

ReadTrainID, BroadcastMessage and ReceiveMessage are procedures defined elsewhere in the project.

During the initial testing of the software, *DisplayTrain* did not perform as expected.

```
① BEGIN DisplayTrain
②     read NumberOfTrains
③     Train = 1
④     WHILE Train <>NumberOfTrains
⑤         ReadTrainID (TrainID)
⑥         ReadLocation (TrainID, LocationX, LocationY)
⑦         DisplayTrainID (TrainID, LocationX, LocationY)
⑧         Train = Train + 1
⑨     ENDWHILE
⑩ END

⑪ BEGIN ReadLocation (TrainID, LocationX, LocationY)
⑫     X = LocationX
⑬     Y = LocationY
⑭     BroadcastMessage (TrainID)
⑮     ReceiveMessage (X, Y)
⑯ END

⑰ BEGIN DisplayTrainID (TrainID, LocationX, LocationY)
⑱     display TrainID at X, Y
⑲ END
```

**Question 21 continues on page 13**

**Question 21 (continued)**

You have been employed to locate any points of error and recommend solutions to the algorithm.

- |       |  |          |
|-------|--|----------|
| (i)   | Design and perform a desk check. The test data should include NumberOfTrains = 0, 1 and 2.   | <b>3</b> |
| (ii)  | Explain, with reference to your desk check, why the algorithm does not work. (The test data should include NumberOfTrains = 0, 1 and 2.) | <b>3</b> |
| (iii) | How would you modify the algorithm to ensure that the software component operates as intended?   | <b>4</b> |
- (b) A team of software programmers is asked to put together a package similar to the *DisplayTrain* program. All team members are asked to find a solution and then pool their discoveries. One of the team members decides to use the Internet and downloads a run-time component from another manufacturer's closed website. However, this member does not give the website address and details of who actually wrote the code. The code is passed on to the team as the member's programming code.
- |      |   |          |
|------|---|----------|
| (i)  | Outline the ethical issues that are involved in this scenario.  | <b>4</b> |
| (ii) | Discuss ways in which management could ensure that the software team carry out their responsibilities as software developers. | <b>6</b> |

**End of Question 21**

**Question 22** (20 marks) Use a SEPARATE writing booklet.

You have been offered a job to maintain inventory information for a warehouse of a bicycle company called Mike's Bikes.

You are required to develop a program for this bicycle company which is able to:

- update the inventory file with daily transactions from a transaction file;
- print an error message if the quantity on hand of an item is less than three.

The inventory file is a random access file with the following record format:

	Stock number	Item description	Quantity on hand	Unit price
Eg	999	xxxxxxxxxxxxxxxx	9999	999.99

The transaction file contains the daily transactions of items shipped out of the warehouse, or items received by the warehouse. The order of transactions is the order in which they occurred. The transaction file record consists of a stock number and a quantity. If the quantity is positive, the transaction represents items received. If the quantity is negative, the transactions represent items shipped. The transaction file is a sequential file with the following record format:

Stock number	Quantity
--------------	----------

The stock number is a three-digit integer and the quantity is a four-digit integer. Assume that '999', as a stock number entry in the transaction file, is an end-of-file indicator.

Here is a sample of the inventory file:

Stock number	Item description	Quantity on hand	Unit price
1	handle bars	10	186.92
2	pedals	5	85.00
3	wheels	3	99.50
4	tyres	12	24.95

**Question 22 continues on page 15**

## Question 22 (continued)

Here is a sample of a transaction file:

Stock number	Quantity
1	-2
3	-1
2	8
1	15
1	-2
2	-2
999	-2

After the update, the inventory file should contain the following information:

Stock number	Item description	Quantity on hand	Unit price
1	handle bars	21	186.92
2	pedals	11	85.00
3	wheels	2	99.50
4	tyres	12	24.95

- (a) (i) Design the interface for entering items into the transaction file. **3**
- (ii) Draw an IPO diagram that represents the inventory file update process. **4**
- (iii) Using either a flowchart or pseudocode, write an algorithm that will: **7**
- update the inventory file (a random access file) using the transaction file;
  - print a message on the terminal screen if a match cannot be found between the inventory stock number and the transaction stock number; and
  - print an error message if the quantity on hand is less than three.
- (b) Documentation is required throughout the development of this software solution. **6**

Identify TWO types of documentation used in different stages of the development cycle and justify the use of each type of documentation for its particular stage.

**End of Question 22**

**Question 23** (20 marks) Use a SEPARATE writing booklet.

The way organisations undertake business has changed dramatically, with faster and smarter hardware and software. Network communications technology has been emerging as a result.

An analyst has been employed to develop a new computer system for a country medical practice. The practice has evolved by amalgamation of small medical practices in four country towns in NSW. In the final structure there will be six doctors, all of whom have basic computer skills, and who will generally operate in their own town.

- (a) The following is a BNF syntax definition used by the new network communications system.

```

<identifier>:: = <letter> | _<letter or digit>
<upper_case>:: = A|B|C|...|X|Y|Z
<lower_case>:: = a|b|c|...|x|y|z
<letter>:: = <upper_case> | <lower_case>
<digit>:: = 0|1|2|...|7|8|9
<special_character>:: = "|#|%|$'|'(l)|*|+|-|,|.|/|:|=|<|>|||
<space>:: = ASCII character 32
<letter or digit>:: = <letter> | <digit>
<number>:: = <decimal> | # <hexadecimal>
<integer>:: = <digit> | <digit> <integer>
<endline>:: = ASCII character 13
<comment>:: = // <uppercase> <endline> | <lower_case> <endline> |
               <digit> <endline> | <special_characters> <endline> | <space>
               <endline> | <endline>

```

- (i) Identify and explain ONE problem with the BNF technique shown. 3
- (ii) In messages being sent, a <hexadecimal> value is required to indicate the beginning and the ending of a message component. Using your understanding of what a hexadecimal number is, write a syntax rule in BNF to define <hexadecimal>. 3

**Question 23 continues on page 17**



## Question 23 (continued)

(b) Assess the possible effects of emerging network communications technology on the everyday usage of this system. **5**

(c) The new network communications system will provide the major components of:

- a central store of patient medical records;
- centralised patient billing, and handling of payments from medical funds to doctors; and
- one point of contact for patients via a single receptionist.

As the amalgamation is to occur in three months time, the major components of the system need to be operating at that time.

(i) Outline ways the analyst could involve each different type of user in the process of defining and understanding the problem. **3**

(ii) Evaluate the different software development approaches available for this network communications system. **6**

**End of Question 23**

## Section III

20 marks

Attempt either Question 24 or Question 25

Allow about 35 minutes for this section

Answer the question in a SEPARATE writing booklet. Extra writing booklets are available.

If you include diagrams in your answer, ensure that they are clearly labelled.

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Marks

Question 24 — Evolution of Programming Languages (20 marks)

- (a) For each of the code fragments, identify the programming paradigm used. Justify your response by describing the features of the paradigm evident in each example. 3

**FRAGMENT 1**

```
hair(sally,red).  
hair(john,brown).  
hair(sue,black).  
  
?-hair(sally,X)
```

**FRAGMENT 2**

```
(setq friends '((sally red) (john brown) (sue black)))  
  
(defun hair (y)  
  (loop for x in '(0 1 2)  
        when (member y (nth x friends)) do  
          (print (cdr (nth x friends))))))  
  
(hair 'sally)
```

- (b) Discuss the reasons for the emergence of the object-orientated programming paradigm. 5

Question 24 continues on page 19

## Question 24 (continued)

- (c) This small program was written to calculate the area of rectangles. The program should stop when the user enters 0 as the height of the rectangle.

```

① program test;
② uses
③     Objects;
④ type
⑤     PRectangle = ^TRectangle;
⑥     TRectangle = object (TObject)
⑦     private
⑧         height, width : integer;
⑨     public
⑩         function area:integer;
⑪     end;
⑫ function TRectangle.area:integer;
⑬ begin
⑭     area :=(height*width);
⑮ end;
⑯ var
⑰     InstRectangle : TRectangle;
⑱ {Code section *****}
⑲ begin
⑳     while InstRectangle.height <> 0 do
㉑     begin
㉒         write('Enter height');
㉓         readln(InstRectangle.height);
㉔         write('Enter width');
㉕         readln(InstRectangle.width);
㉖         writeln('The area is ', InstRectangle.area);
㉗     end;
㉘ end.

```

- (i) When this program is run, nothing happens. Describe the logic error located between lines 18 and 28, and describe TWO methods of correcting this error. **3**
- (ii) The user would also like the program to be able to calculate the area of a triangle, using the formula:  $\text{area} = \frac{1}{2} \times \text{base} \times \text{height}$ . Write a definition for a triangle, to be added to this program. **3**

**Question 24 continues on page 20**

## Question 24 (continued)

- (d) Justify the programming paradigm you would choose to develop the system described below. **6**

A new international airport will be installing a computer-controlled baggage sorting system. Each piece of baggage will have a bar-coded label attached to it that indicates the destination and class of the passenger. The baggage will move along a conveyor belt until it reaches the chute assigned to its category, into which it will be automatically tipped. At the bottom of the chute, unloaders will pick up the baggage and load it onto trolleys to be transported to the aircraft.

At the beginning of each day, the day's flight schedule will be loaded into the system, and the number of chutes required for each flight determined using the default of one chute per destination and class. The system will determine where bottlenecks may occur, or where the number of chutes required can be compressed. Automatic 'Compression Rules' are to be used. Chutes will then be assigned to each destination and class. Chute assignments will be automatically changed by the system as the number of people booked on any flight varies throughout the day.

**End of Question 24**

**OR**

**Question 25 — The Software Developer’s View of the Hardware**

(20 marks)

- (a) Compare and contrast character representation in ASCII and hexadecimal. 3
- (b) On a specially formatted audio compact disk, the audio player initially reads the CD\_Header information. The CD\_Header is located at the start of the CD and describes the properties of the disk. Using the CD\_Header information, the audio player reads the Song\_List\_Header. The Song\_List\_Header specifies the properties for each song on the disk. The maximum number of tracks any CD can hold is 50. A program can be written to correctly read and play each track from the CD using the following information: 5

Special Data Types (Records):

TIME:

Minutes	:Integer
Seconds	:Integer

CD\_Header:

CD_Type	:Character
Total_CD_Time	:TIME
Number_of_Songs	:Integer
Location_of_Data	:TIME
Location_of_Song_List_Header	:TIME

Song\_List\_Header:

Location_of_Song	:TIME
Length_of_Song	:TIME

Commands (Functions):

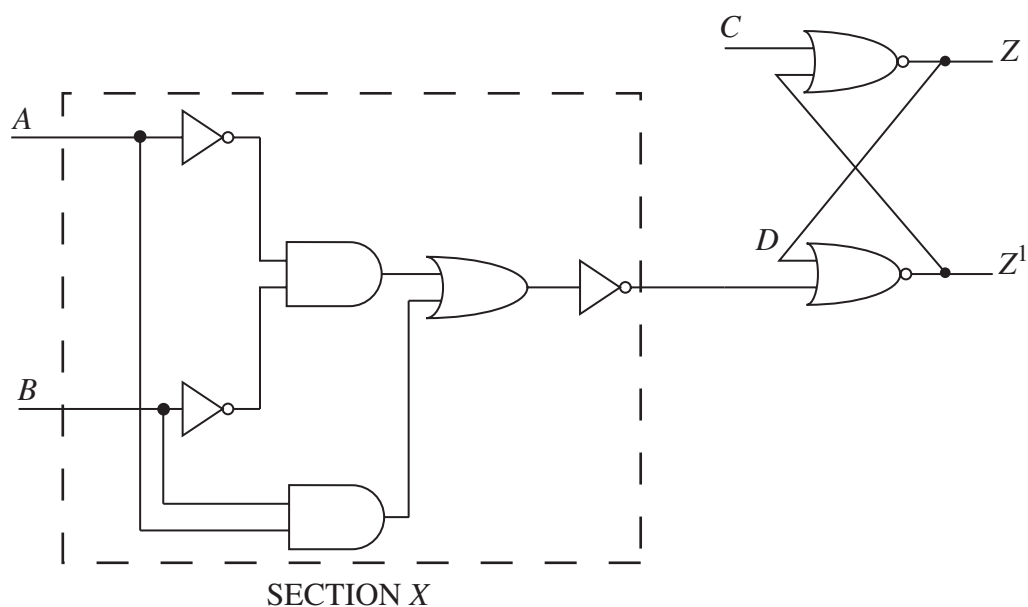
Seek(TIME)	Position the CD player’s laser to the position TIME
Display(TIME)	Display the variable TIME
READ(x)	Read data from the CD and assign to variable x for all data types
Play	Play the CD at the CD player’s current laser position
Pause	Maintain CD player’s laser position, stop reading data
Stop	Stop CD player and position the laser to start of disk

Using pseudocode, write a generalised function that will read data from the CD to a variable of type CD\_Header, and to an array that holds information about each track.

**Question 25 continues on page 22**

Question 25 (continued)

- (c) The diagram shows a basic circuit for the storage of binary information in a computer. The initial state of each of  $A$ ,  $B$ ,  $C$  and  $D$  is zero. 6



Identify the logic gate in SECTION X, and determine the state of  $Z$  and  $Z^1$  if input  $B$  changes to a value of 1. Use truth tables to justify your answer.

**Question 25 continues on page 23**

## Question 25 (continued)

- (d) A system is to be designed to allow a person to switch on a light in a room safely. The system will have three inputs: the state of a fault detector; the state of a door into the room; and the state of the light switch in the room. The fault detector is active if a fault is detected in the lighting system. For security reasons, the door must be closed for the light to go on. 6

The light in the room will be turned on if:

- the fault detector is inactive; and
- the door is closed; and
- the person has turned on the light switch.

The table shows the logic states for the different components of the lighting system.

<i>Equipment</i>	<i>Description</i>	<i>Logic state</i>
Fault detector	active	TRUE
Door	closed	TRUE
Light switch	on	TRUE
Light	on	TRUE

Design a circuit for the lighting system, and use a truth table to verify your design.

**End of paper**

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